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THE STATUS OF *CRYPTOCHIRUS CORALLIODYTES* HELLER AND *LITHOSCAPTUS PARADOXUS* MILNE EDWARDS (BRACHYURA: CRYPTOCHIRIDAE)

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Abstract.—The types of *Cryptochirus coralliodytes* Heller and *Lithoscaptus paradoxus* Milne Edwards were examined and found to differ in sculpture of the carapace, the epistome, and relative lengths of the carpus and merus of the fifth pereopod among other features. Therefore, the latter is removed from the synonymy of the former. The type of *Cryptochirus rugosus* Edmondson was examined and found to be indistinguishable from *C. coralliodytes*; thus, *C. rugosus* is placed in synonymy with *C. coralliodytes*. The available data suggest that *Cryptochirus bani* Fize & Serène is synonymous with *L. paradoxus*. Lectotypes are designated for *C. coralliodytes* and *L. paradoxus* and are described and figured.

Two years after the description of the first known coral gall crab, *Hapalocarcinus marsupialis* Stimpson, 1859, the second recorded species, *Cryptochirus coralliodytes,* was described by Heller (1861a:19). Milne Edwards (1862:F10) followed this with the description of a third species, *Lithoscaptus paradoxus*. All three species were rather incompletely described, probably because they were reasonably different from most other brachyurans known at the time. Although this inadequacy has not been a problem for the first species it has resulted in some misunderstanding regarding the latter two species.

The problem regarding the identities of *C. coralliodytes* and *L. paradoxus* can be traced to the failure of authors to examine type specimens or to carefully consider information provided in the original descriptions that should have been useful in separating the two species. Paulson (1875) was the first to place the two in synonymy, but did so by erroneously considering *L. paradoxus* a senior synonym of *C. coralliodytes*. He did not justify his action. Richters (1880) agreed, but did correct the order of synonymy. Rathbun (1897) also noted Paulson's error. After Calman (1900) followed Paulson's action, all authors up until the review of the family of Fize & Serène (1957) attributed the synonymy of the two species to Paulson and/or Calman without question or examination of the types (e.g., Edmondson 1933, Shen 1936, Utinomi 1944). Fize & Serène (1957) discussed *Cryptochirus* in detail and examined the syntypes of *Lithoscaptus* and *Cryptochirus* that are in the collection of the Muséum National d'Histoire Naturelle, Paris. In spite of doing so, they upheld the synonymy of the two species. More recently, Takeda & Tamura (1980) reviewed *Cryptochirus,* but did not alter the status of the two species.

I examined the syntypes of *C. coralliodytes* and *L. paradoxus* and determined that they are not synonymous. Herein I designate lectotypes for each species and conclude that Heller's species is a subjective senior synonym of *Cryptochirus rugosus* Edmondson, 1933. Because *C. rugosus* is the type species of the genus *Favicola* Fize &

Serène, 1957, the latter should now be considered a subjective junior synonym of *Cryptochirus* Heller, 1861.

Materials and Methods

I examined the male and female syntypes of *Cryptochirus coralliodytes* Heller housed in the Muséum National d'Histoire Naturelle, Paris (MNHN) and Naturhistorisches Museum, Vienna (NMW), respectively; the syntypes of *Lithoscaptus paradoxus* Milne Edwards in the MNHN; and the holotype of *Cryptochirus rugosus* Edmondson held in the B. P. Bishop Museum, Honolulu (BPBM). Additional material examined came from the BPBM and my own collections (denoted as HAP and PHAP) made in Micronesia in 1984. The Micronesian material is deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM). Place names for collection sites in the Caroline Islands are from Bryan (1971). At the first occurrence in the text of each locality, the new orthographic spelling (Motteler 1986) is given followed parenthetically by the former spelling. Subsequently, only the new spelling is used.

Some of the Micronesian material was used in the preparation of the figures and for study by Scanning Electron Microscopy (SEM). In preparation for SEM, specimens were dissected and cleaned by gentle mechanical agitation, and brushing with a fine paint brush. Specimens were then transferred to 100% ethanol via a graded series and air-dried overnight. Dried specimens were mounted on stubs and sputter-coated with gold-palladium and viewed with a Cambridge Stereoscan-100 microscope at an accelerating voltage of 10 kv.

Drawings were made with a camera lucida mounted on a Wild M-5 microscope. The cheliped was drawn so that the outer surface of the manus is in the plane of the printed page. This distorts the relative proportions of the other segments, particularly the merus. Male pleopods were prepared for illustration by lactic acid digestion and staining using methods described in Kropp & Manning (1987), except acid fuchsin was substituted for fast green.

The carapace length and width of each specimen were measured to the nearest 0.1 mm with an ocular micrometer on a Wild M-5 microscope and are reported in mm as length × width. Abbreviations used in the text are: m, meters; MXP, maxilliped; ov, ovigerous; P, pereopod; PLP, pleopod; and TL, type locality.

In the systematic account, I have restricted the generic synonymies to the original usage of a name for each taxon. For each nominal species the type locality and the location of the type specimen are included.

Systematic Account

Cryptochirus Heller, 1861

Cryptochirus Heller, 1861a:19 [type species: *Cryptochirus coralliodytes* Heller, 1861a: 19 by monotypy; gender masculine].

Favicola Fize & Serène, 1957:84 [type species: *Cryptochirus rugosus* Edmondson, 1933:6; subsequent designation by Serène (1966:396); gender masculine (see Remarks)].

Remarks.—The International Code of Zoological Nomenclature (ICZN, 1985) specifies that a genus-group name ending in a noun of variable gender, such as *-icola,* should be treated as masculine unless its author specifies that it is feminine or treats it as feminine by the use of feminine species-group names [Article 30 (a) (i)]. Serène (1966) was the first to use *Favicola* as a distinct generic name and did so with masculine species-group names. Therefore, the gender of *Favicola* is masculine.

Cryptochirus coralliodytes Heller
Figs. 1–3

Cryptochirus coralliodytes Heller, 1861a:19 [TL: Red Sea; lectotype NMW, paralectotype MNHN]; 1861b:370, pl. IV, figs. 33–39.

Cryptochirus corralliodytes Heller, 1861a:19 [incorrect original spelling].

Cryptochirus rugosus Edmondson, 1933:6, fig. 1, pl. 1 [TL: Line Islands, Teraina [= Washington Island]; holotype BPBM S3668].

Types.—Two syntypes of *C. coralliodytes* are extant. The female syntype is ovigerous, 6.6 × 4.5 mm, in NMW. It is herein designated the lectotype. The specimen is disarticulated, with the carapace being detached from the thorax which is missing. The right P-3 to P-5, mouthparts, antennae, and antennules are missing. The abdomen is detached, in poor condition, some pleopods are present. The male syntype, 5.0 × 3.0 mm, is in good condition having all pereopods, mouthparts, and pleopods present. It is in MNHN and is herein designated the paralectotype. I examined the holotype of *C. rugosus* at the BPBM in 1984, but have not been able to re-examine it as it is now missing (B. Burch, pers. comm. to R. B. Manning, 1987). It is a female and agrees with the lectotype of *C. coralliodytes.*

Material examined.—Red Sea [no specific locality]: lectotype, ♀, 6.6 × 4.5, (NMW); paralectotype, ♂, 5.0 × 3.0, (MNHN 198-63). Caroline Islands: Belau (Palau): Ngerekebesang (Arakabesan) Is. [07°21′N, 134°27′E], north side of cove on west side of island, PHAP 078, 4 m, 7 Jul 1984, on *Platygyra lamellina* (Ehrenberg, 1834), 2 ♀ (1 ov), 1 ♂. Pohnpei (Ponape): Sokehs Passage [07°00′N, 158°11′E], patch reef bordering west side of reef, PHAP 270, 2 m, 16 Nov 1984, on *P. daedalea* Ellis & Solander, 1786, 2 ♀. Mariana Islands: Guam: Double Reef [13°36′N, 144°50′E]; shoreward side of main patch reef, HAP 125, 9 m, 24 Feb 1984, on *Platygyra* sp., 1 ♀, 1 ♂. Line Islands: Teraina (=Washington Is.) [04°43′N, 160°24′W], 1 ♀ (BPBM S3668, holotype of *Cryptochirus rugosus* Edmondson).

Description.—Lectotype female (Figs. 1, 2), except mouthparts, antenna, antennule, and epistome (based on material from Micronesia). Carapace about 1.5 times longer than broad, widest near midlength. Anterior carapace with inverted V-shaped depression, anterior gastric region slightly inflated; midcarapace with clusters of prominent, rounded tubercles on posterior gastric, anterior and posterior epigastric regions; posterior surface with scattered pointed and rounded tubercles. Regions of posterior half of carapace set off by series of well-formed grooves, epigastric region divided into anterior, posterior parts by distinct groove. Anterolateral margin of carapace spinous.

Anterolateral angle of carapace with single tubercle, apex exceeding inner orbital angle, latter swollen, with tubercle. Front concave, with few tubercules just behind margin; width about ½ that at anterolateral angles, latter about 2/5 greatest carapace width. Orbit deeply V-shaped.

Epistome with subparallel longitudinal ridges laterally, median area produced anteriorly into longitudinal ridge subequal in thickness to lateral ridges; anterior margin with few tubercles, slightly sinuous, with scant median indentation.

Basal segment of antennular peduncle with elliptical projection extending beyond length of eyestalk, apex spine-tipped, no angled lateral lobe. Dorsal surface flat, with few pointed tubercles. Mesial margin spinous. Ventral surface of second antennal segment with scattered granules, distal margin toroidal (Fig. 2c).

Eye directed anterolaterally, extending beyond anterolateral angle; cornea subterminal, occupying distal third of stalk in dorsal view. Stalk mostly exposed, broadening proximally; ventral surface with few granules.

MXP-3 with exopod, mesial margin of ischium convex; outer surface with distally-raised granules. Merus longer than broad, width less than half that of ischium. Carpus shorter than length of propodus and dactylus combined.

Endopod of MXP-1 triangular, mesial

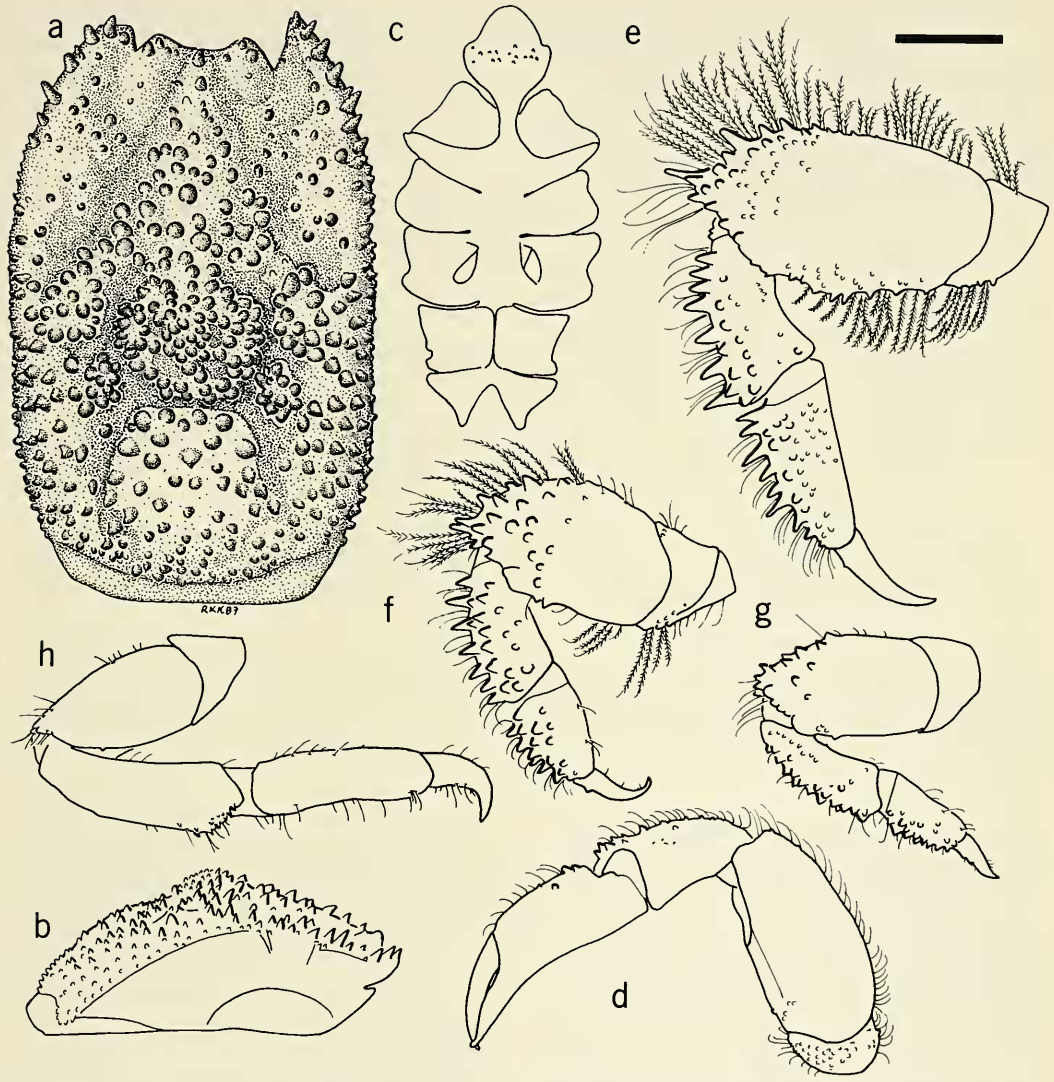

Fig. 1. *Cryptochirus coralliodytes*, ♀ (a, b, d–h from lectotype, c from Guam ♀, USNM): a, Carapace (dorsal view); b, Carapace (lateral view); c, Thoracic sternites; d–h, P-1 to P-5. Scale: a = 0.8 mm; b = 2.1 mm; c–h = 1 mm. [Setae on surface of carapace and pereopods not shown.]

margin about ⅔ length of lateral margin, anterior margin with sharp curve occurring mesially, lined with stout simple setae.

Chelipeds (P-1) with few scattered simple, pappose setae on upper margins. Dactylus longer than dorsal margin of palm, cutting edges of fingers entire. Dorsal margin of palm entire, outer and upper surfaces with few granules proximally. Manus slightly smaller than merus.

Dorsal margin of merus of P-2 with spines distally, fringed with pappose setae of length >2 times that of spines; outer surface flat, with granules dorsodistally, ventrally; ventral margin relatively straight, with few tubercles, fringed with pappose setae; ven-

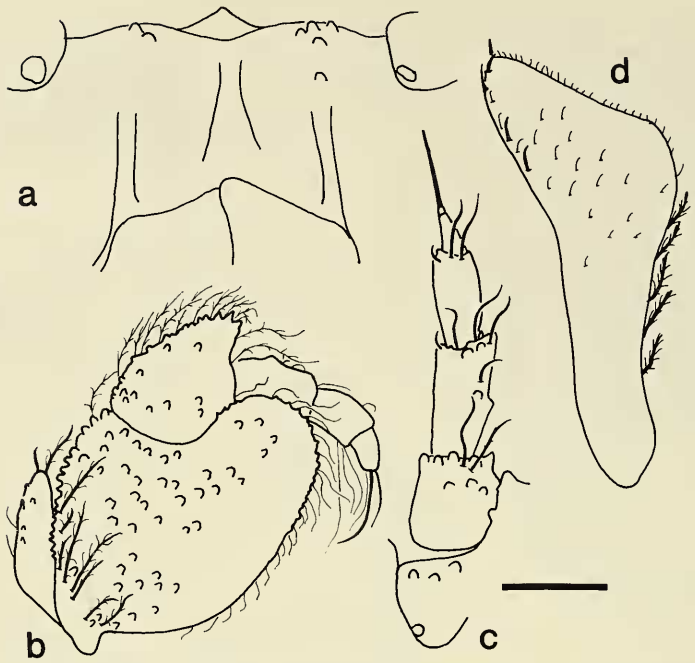

Fig. 2. *Cryptochirus coralliodytes*, ♀ (Guam, from SEM micrographs): a, Epistome; b, MXP-3 (outer view); c, Antenna (ventral view); d, Endopod of MXP-1 (outer view). Scale: a = 0.3 mm; b = 0.5 mm; c, d = 0.2 mm.

trodistal angle with prominent tubercles (tubercles worn on lectotype). Merus height <2 times that of carpus. Dorsal margins of carpus and propodus with robust spines, simple setae; outer surfaces with tubercles dorsally, ventrally; carpus subequal in length to propodus. Dactylus with proximal tooth dorsally; tip with subterminal pore. P-3, P-4 similar in form to P-2, stockier, P-4 less setose. P-5 elongate, smooth; carpus longer than other segments; propodus, dactylus directed anteriorly.

Sternite of P-1 with few granules, that of P-4 with median suture. Female opening longitudinal, oval, with hood; PLP-2 biramous, PLP-3 uniramous.

Variations.—May have spines instead of tubercles at inner orbital angles, anterolateral angles, and on anterior surface of carapace. Spines vary as to number and sharpness. The width and depth of the grooves on the carapace varies considerably. The dactylus of P-2 may be missing. Smaller females may have a deeper depression on the anterior carapace, may be less spiny, and have a more elongate projection of the antennule base than larger females. The carapace length : width ratio ranged from 1.2 to 1.7 with most crabs within 1.4 to 1.6.

Paralectotype male (Fig. 3).—Similar to, smaller than female. Carapace regions distinctly marked as female, spines, rounded tubercles less pronounced. Projection of antennule base more elongate, pointed. P-1 robust, palm inflated, with tubercles; dactylus slightly longer than dorsal margin of palm. Abdominal somites 5–7 narrower than somites 3–4; telson broadly rounded. PLP-1 reaching middle of sternite of P-1; slightly curved, apex sharply pointed, directed slightly laterally; lateral margin with stout setae.

Variations.—P-1 much less robust in proximal tooth on the dorsal surface of the

smaller males, with the dactylus relatively longer than paralectotype. Regions of carapace may have fewer tubercles.

Lithoscaptus Milne Edwards, 1862

Lithoscaptus Milne Edwards, 1862:F10 [type species: *Lithoscaptus paradoxus* Milne Edwards, 1862:F10, by monotypy; gender masculine.]

Lithoscaptus paradoxus Milne Edwards
Figs. 4–6

Lithoscaptus paradoxus Milne Edwards, 1862:F10 [TL: Reunion; lectotype, MNHN].

Cryptochirus coralliodytes var. *rubrolineata* Fize & Serène, 1957:40, fig. 5D, pl. 14, figs. E–H [TL: Nhatrang, Vietnam; location of type unknown].

Cryptochirus coralliodytes var. *cubrolineata.*—Fize and Serène, 1957:201 [erroneous spelling].

Cryptochirus coralliodytes var. *fusca* Fize and Serène, 1957:40, fig. 5B [TL: Nhatrang, Vietnam; location of type unknown].

Cryptochirus coralliodytes var. *parvulus* Fize and Serène, 1957:40, fig. 5C [TL: Nhatrang, Vietnam; location of type unknown].

Cryptochirus bani Fize and Serène, 1957: 44, figs. 5F, 6, pl. 1, fig. 7 [TL: Nhatrang, Viet-Nam; location of type unknown].

Type.—Two specimens are in the vial from the MNHN labelled *Lithoscaptus paradoxus* "TYPE." One is a nonovigerous female that is herein designated the lectotype. The carapace of this female is somewhat misshapen, but still recognizable. Both P-2 are missing, but the remaining pereopods are present as are all mouthparts. The pleopods are present and are uniramous. The second specimen is *Cryptochirus coralliodytes* Heller. Milne Edwards indicated which specimen on which he based his description by his reference to uniramous female pleopods (1862:F12). For this reason the larger female is selected as the lectotype.

Material examined.—Indian Ocean: Reunion Island [20°18′S, 57°29′E], lectotype, 1 ♀ 6.4 × 5.3 (MNHN). Pacific Ocean: Caroline Islands: Belau: Ngeruktabel Is., patch reef among rock islands on northeast shore, PHAP 045, 2 m, 2 Jul 1984, on *Goniastrea pectinata* (Ehrenberg, 1834), 2 ♀ (1 ov), 1 ♂; Mariana Islands: Guam: Luminao Reef [13°28′N, 144°39′E], reef flat toward Magundas, HAP 315, 1 m, 13 Oct 1984, on *P. daedalea,* 2 ♀ (ov), 1 ♂; Cook Islands: Rarotonga [21°14′S, 159°46′W], Ararua, Wilder and Parks, Jun-Jul 1929, [no host], 13 ♀ (ov) (BPBM S3221).

Description.—Female, based on lectotype in conjunction with a Guam female (Fig. 4, 5, USNM). Carapace about 1.2 times longer than broad, widest just posterior to midlength. Anterior carapace with broadly W-shaped depression having scattered spines; anterior gastric region slightly inflated; median gastric with 2 depressions; mid to posterior carapace with many rounded tubercles, regions of carapace not well defined; cardio-intestinal region rimmed anteriorly, laterally with depression. Anterolateral margin of carapace spinous.

Anterolateral angle of carapace with single spine, apex exceeding inner orbital angle, latter swollen, with subterminal spine. Front concave, entire, width about ½ that at anterolateral angle, latter 2/5 greatest carapace width. Orbit V-shaped.

Epistome with subparallel longitudinal ridges laterally; median area swollen, lacking ridge; anterior margin entire, straight, with scant median indentation.

Basal segment of antennular peduncle with suboval projection extending slightly beyond eyestalk, rounded distally, no angled lateral lobe; dorsal surface flat, without tubercles; entire margin with subequal spines. Ventral surface of second antennal segment with few granules, distal margin with few raised granules.

Eye directed anterolaterally, extending just

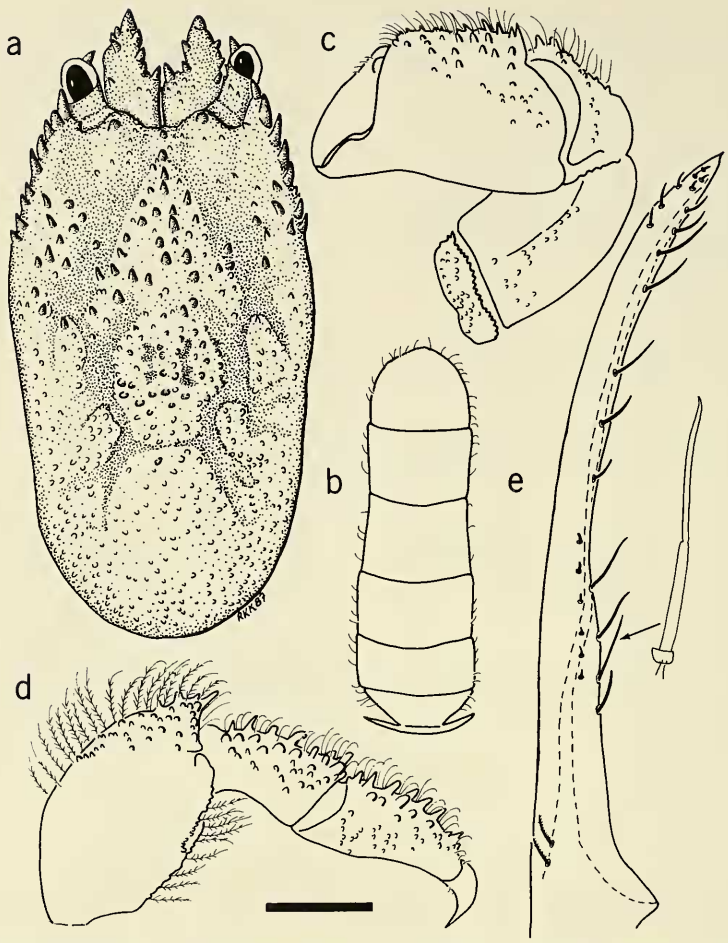

Fig. 3. *Cryptochirus coralliodytes*, ♂, (a–d from paralectotype, e from Guam ♂, USNM): a, Carapace (dorsal view); b, Abdomen; c, Left P-1; d, Right P-2; e, PLP-1 (outer view). Scale: a = 0.9 mm; b–d = 1 mm; e = 0.1 mm.

beyond anterolateral angle; cornea subterminal, occupying distal quarter of stalk dorsally. Stalk mostly exposed, not broadening proximally; ventral surface smooth.

MXP-3 with exopod, mesial margin of ischium slightly convex, outer surface with many distally-raised granules. Merus longer than broad, width less than half that of ischium. Carpus shorter than length of propodus and dactylus combined.

Endopod of MXP-1 subquadrate, mesial margin about 3/5 length of lateral margin; anterior margin with sharp median curve, lined with stout simple setae.

Chelipeds (P-1) with many scattered simple setae on upper margins. Dactylus longer than dorsal margin of palm; cutting edge with low tooth proximally. Dorsal margin of palm with few tubercles proximally, outer surface smooth. Manus much smaller than merus.

Dorsal margin of merus of P-2 with spines distally, fringed with pappose setae of length >2 times that of spines; outer surface flat, with tubercles distally; ventral margin convex, with few tubercles, fringed with pappose setae. Merus height >2 times that of carpus. Dorsal margins of carpus, propodus

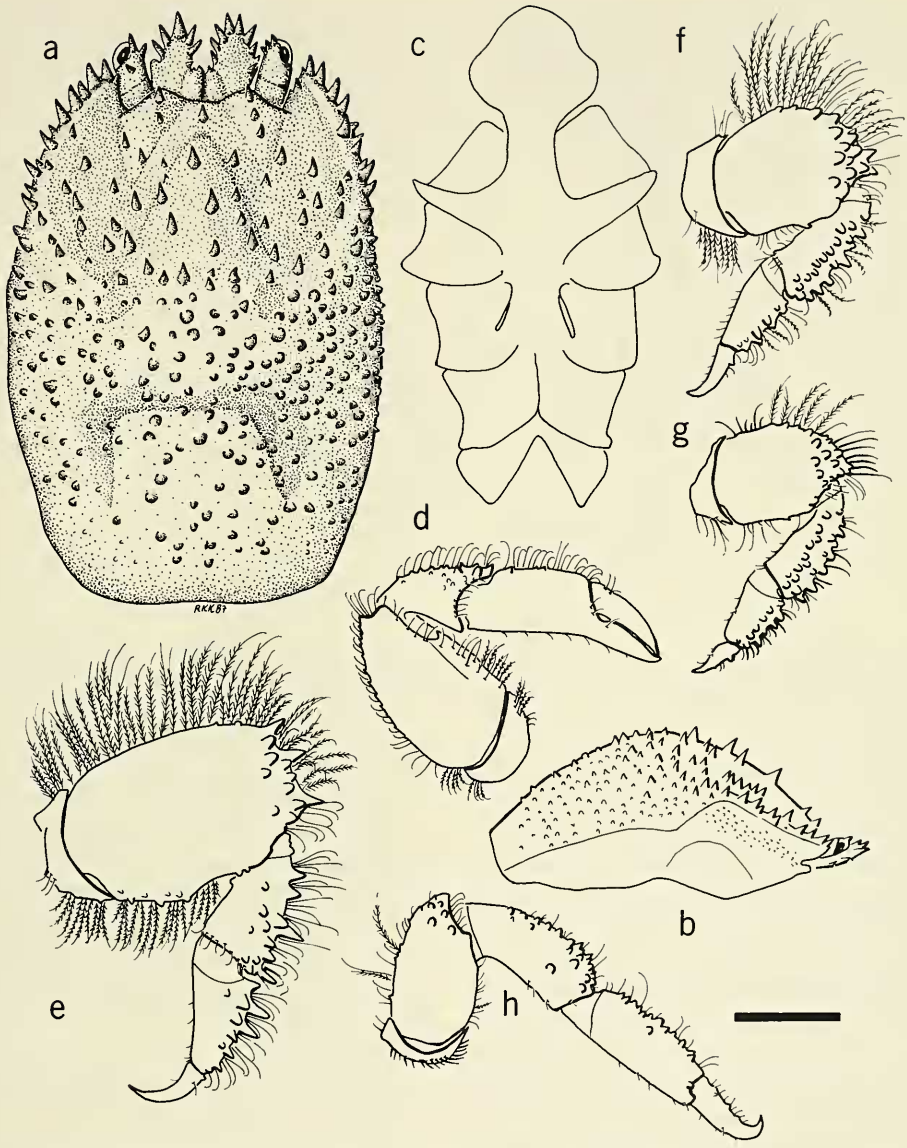

Fig. 4. *Lithoscaptus paradoxus,* ♀ (Guam, USNM): a, Carapace (dorsal view); b, Carapace (lateral view); c, Thoracic sternites; d–h, P-1 to P-5. Scale: a = 0.8 mm; b = 2.1 mm; c–h = 1 mm.

with spines, simple setae; outer surfaces with few tubercles; carpus longer than propodus. Dactylus lacking proximal tooth dorsally, tip with subterminal pore. P-3, P-4 similar in form to P-2; outer surfaces of carpi, propodi with longitudinal row of rounded tubercles near upper margins, upper margins with simple, pappose setae. P-5 elongate, with tubercles dorsally on proximal 3 segments; merus and carpus subequal in length, each longer than propodus; propodus, dactylus directed anteriorly.

Sternite of P-1 smooth, that of P-4 with median suture. Female opening longitudinal, oval, with anterior hood; PLP-2, PLP-3 uniramous.

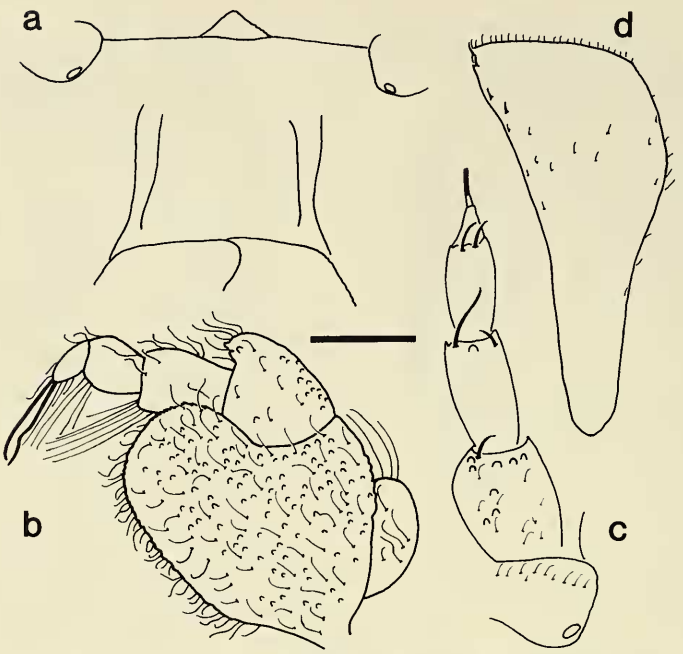

Fig. 5. *Lithoscaptus paradoxus*, ♀ (Guam, from SEM micrographs): a, Epistome; b, MXP-3 (outer view); c, Antenna (ventral view); d, Endopod of MXP-1 (outer view). Scale: a, c, d = 0.2 mm; b = 0.4 mm.

Variations.—Relative sculpture of the carapace variable, particularly the median gastric area which may have depressions from two to four in number which may vary from obvious to faintly detectable. The extent of the depression on the anterior carapace varies from occupying the entire surface between the anterolateral margins to somewhat less. The size and number of spines and/or tubercles is highly variable. The carapace length : width ratio ranged from 1.2 to 1.5 with most crabs within 1.3 to 1.4. In some specimens the lateral projection of the antennule base is more elongate than described. Also, the anterolateral angles of the carapace may extend only slightly beyond the inner orbital angles.

Male.—Based on specimens from Micronesia. Similar to, smaller than female. Carapace detail similar to females, spines proportionally smaller. Projection of antennule base elongate, with apical spine. P-1 robust, palm inflated, with few tubercles; dactylus longer than dorsal margin of palm. Abdominal somites 3–7 similar in width, telson broadly rounded. PLP-1 slightly curved, apex sharply pointed, directed slightly laterally; reaching posterior of sternite of P-1; lateral margin with stout setae.

Variations.—Smaller males have a relatively smooth carapace, with the anterior depressions more distinct. The inner orbital angle may equal or exceed anterolateral angle of the carapace.

Remarks.—The original description of *Cryptochirus bani* by Fize & Serène (1957) did not provide information necessary to distinguish it from *Lithoscaptus paradoxus*. Serène (1962), in a discussion of some material from Rarotonga sent to him by Edmondson, alluded that *C. bani* might be synonymous with *C. coralliodytes*. Serène thought that this material was very similar to *C. bani*. I have examined material from the same collection (BPBM S3221) and found them to be *L. paradoxus*. Without examination of the type of *C. bani*, there is some uncertainty, but it is likely that *C. bani*

is a subjective junior synonym of *L. paradoxus*. Fize & Serène (1957) named three varieties of *C. coralliodytes* based primarily on color differences, giving no substantial morphological data by which to distinguish them. The varieties, *rubolineata, fusca,* and *parvulus* are therefore considered subjective junior synonyms of *L. paradoxus*.

Discussion

Paulson (1875) felt that many taxonomists of the period were not making useful contributions to systematics as a science, and that their research "provides only a useless ballast." He was particularly critical of Heller and A. Milne Edwards. Yet careful consideration of the original species descriptions by Heller and Milne Edwards and comparisons of those with material at hand might have prevented Paulson's confusion of *C. coralliodytes* with *L. paradoxus*. Heller's original species account (1861a:19) was scanty, but the generic description included a characterization of the endopod of the first maxilliped that is useful. This was supported by his later (1861b), more detailed, account which included an accurate figure of the appendage (1861b, pl. IV, fig. 39). The endopod of the first maxilliped is quite different in *L. paradoxus* (triangular in *coralliodytes* versus subquadrate in *paradoxus,* compare Fig. 2d and 5d herein). Heller's figure of the female type (1861b: pl. IV, fig. 33) shows enough carapace detail, despite Edmondson's (1933:4) complaint, to distinguish the two species.

Milne Edwards also gave information sufficient to separate the two species by referring to the uniramous condition of the female pleopods (1862:F12). Although female PLP-2 form is often not a reliable character (McCain & Coles 1979; Kropp & Manning 1987), in this case it is applicable because among the specimens of either species that I have examined, the PLP-2 is consistently uniramous in *L. paradoxus* and consistently biramous in *C. coralliodytes*.

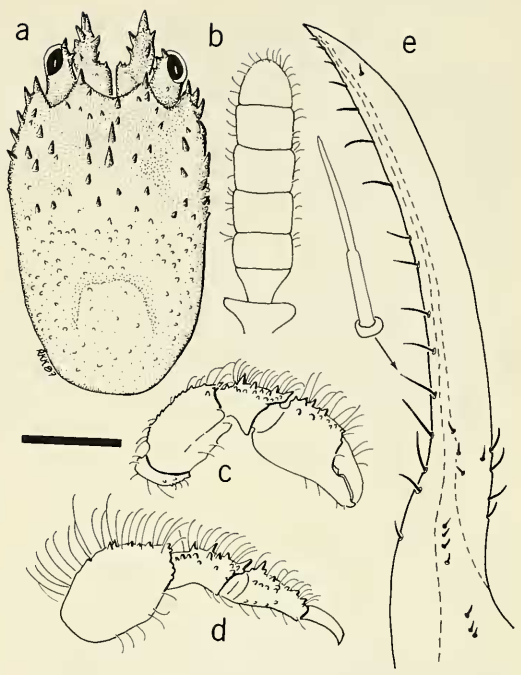

Fig. 6. *Lithoscaptus paradoxus,* ♂ (Guam, USNM): a, Carapace (dorsal view; b, Abdomen; c–d, Right P-1, P-2; e, PLP-1 (outer view). Scale: a–d = 1 mm; e = 0.1 mm.

Several features other than the above information from the original literature allow separation of the two species. The most obvious difference is that the regions of the carapace of *C. coralliodytes* are well defined whereas those of *L. paradoxus* are not. Additionally, in the former, the epistome has a median ridge, and leg P-5 is smooth, with the carpus longer than the other segments whereas there is no median epistomal ridge and leg P-5 is tuberculate dorsally, with the carpus and merus subequal in length in *L. paradoxus*. Leg P-2 permits the two species to be distinguished because the merus is larger relative to the carpus in *Lithoscaptus* than in *Cryptochirus*.

The changes made here have a bearing on the other species presently included in *Cryptochirus* and *Favicola*. I am reviewing these species and will clarify their status as a part of a revision of the genera of cryptochirids.

Acknowledgments

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